RECREATIONAL USE SURVEY OF THE EAST FORK WHITE AND WHITE RIVERS, 2003

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2004

EXECUTIVE SUMMARY

1. A roving creel survey was used to estimate recreational activity and commercial fishing on 128.5 miles of the East Fork White and White Rivers from Williams Dam in Lawrence County to East Carmel in Knox and Gibson Counties from April 1 to October 31, 2003. Effort was also estimated from data collected by an observer in an airplane flown over the study area during the same time period and compared to estimates from the roving creel survey.

2. Angler, hunter, and miscellaneous recreational effort totaled 326,271 h for the survey period. More effort was expended in the upstream sector (176,678 h) than in the downstream sector (149,593 h). Miscellaneous recreational users (e.g. campers, swimmers) spent more hours (93,756 h) on or near the river than any other group. Shore-angler effort (83,825 h) was similar to boat-angler effort (79,459 h), followed by recreational boaters (65,080) and hunters (4,152 h).

3. Shore anglers were the dominant user in the upstream sector followed by miscellaneous users, boat anglers, recreational boaters, and hunters. In contrast, recreational boaters were the dominant user group in the downstream sector followed by boat anglers, miscellaneous users, shore anglers, and hunters. Almost all of the effort in the downstream sector was directed towards either catfish or “anything.” Anglers in the upstream sector preferred to catch a greater diversity of fish.

4. Angler effort totaled 163,284 h (1,271 h/mi) for the entire study area. Average trip length calculated from completed trips was 3.1 h (n = 297; SE = 0.11); thus, anglers made an estimated 52,672 trips to the river from April to October 2003. Anglers in Indiana spent an average $37/trip (total trip expenditures; USFWS 2001), which equates to $1,948,864 for the survey season.

5. Total catch was estimated at 176, 580 fish (1,374 fish/mi). Catch rate for the study period was 1.1 fish/h. Approximately 62% (109,141) of the fish caught were harvested (0.56 fish/h) for a total weight of approximately 195,819 lbs.

EXECUTIVE SUMMARY (CONT.)

6. Effort estimated from flight counts and creel counts differed by more than an order of magnitude. Total recreational effort estimated from flight counts was 18,684 h (SE = 1,006) compared to 326,271 h estimated from creel counts. There were significant relations ($P < 0.001$) between daily estimates of effort from flight and creel counts of boat anglers, but the regression line only explained 30% of the variation in effort. There were also significant relations ($P < 0.001$) between daily estimates of effort from flight and creel counts of shore anglers, but the regression line explained even less variation in effort ($r^2 = 0.17$).

7. Commercial effort was estimated at 2,712 net-days (SE = 153), which is lower than the 45,196 net-days that were reported by commercial fishermen. Monthly reported and estimated commercial fishing efforts were significantly correlated ($n = 7$; $r = 0.9285$; $P = 0.003$). Total estimated catch was 27,744 fish (SE = 1,402), of which 72% were harvested (19,941) for a total weight of 60,611 lbs; commercial fishermen reported catching 96,327 lbs of fish. Commercial fishermen harvested significantly larger channel catfish, blue catfish, and freshwater drum than sport anglers.

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INTRODUCTION

A major proportion of angler effort in Indiana may be distributed among large rivers in the state, but estimates of effort and catch by anglers utilizing the resources are unavailable for many of these systems. Large rivers provide opportunities not only for anglers, but also for other types of recreational activities (e.g. boating, canoeing, swimming, etc.). Managers benefit from having current information on the recreational value of the resource in case the river is degraded by human activities; for example, the fish kill on the West Fork White River in 1999 (Ball 2002; Keller 2000). Data gathered from a creel survey of the river will provide estimates of angler effort and catch, along with other recreational activities and provide an estimate of the monetary value of the fishery. The information collected will also help biologists make future management decisions regarding the fishery.

The East Fork White River begins in Bartholomew County and flows 239 miles southwest and joins the West Fork White River in Pike and Davies County to form the White River. The East Fork White River drains approximately 5,725 square miles up to the confluence with the West Fork, which drains approximately 5,372 square miles. Commercial fishing is allowed from where the Lost River empties into the East Fork White River (river mile 83) to confluence with the Wabash River. Limited data on sport angler effort is available for the East Fork White River from a creel survey at Williams Dam (Christensen 1967) and Hindostan Falls (Christensen 1968). However, Christensen's study was only during May and June, and focused mainly on the freshwater drum fishery.

The objectives of this project were to 1) estimate effort and catch of sport and commercial fishermen on 128.5 miles of the East Fork White and White Rivers, 2) estimate effort of other recreational activities on the same stretch of river, 3) compare effort estimates from flight counts and clerk counts, and 4) compare commercial effort and catch estimates with data reported by commercial fishermen.

METHODS

A roving creel survey design was used to estimate recreational activity on 128.5 miles of the East Fork White River from Williams Dam in Lawrence County to East Carmel in Knox and Gibson Counties (Figure 1). The creel survey began April 1, 2003 and ended October 31, 2003. The study area was partitioned into two sectors. The upstream portion of the study area (Sector 1) began at Williams Dam and ended at the U.S. 231 Bridge in Dubois County and was divided into fours sections (Table 1; Figure 2). The downstream sector (Sector 2) began at the U.S. 231 Bridge and ended at the confluence with the Wabash River. Sector 2 was divided into four

sections, but starting in June 2003, the four sections were divided into seven sections because the sections were too long for the creel clerk to complete in one shift (Table 2; Figure 3).

One creel clerk was assigned to each sector and covered only one section during each workday. Sections were assigned unequal probabilities based on biologists' knowledge of the study area. The creel design was stratified by kind-of-day (KOD; weekend or weekday) and time-of-day (TOD; AM or PM) with equal probabilities for both. Section and shift combinations were chosen with replacement for each workday in a two-week pay period. Three of four weekend days and seven of ten weekdays were selected per two-week period. Creel clerks made one progressive count per shift via boat in the section they were assigned to for that day. Landmarks within each section were chosen as stations to help the clerk stay on a time schedule and to reduce length-of-stay biases associated with progressive counts (Pollock et al. 1994). Stations were randomized as starting points along with travel direction (upstream or downstream). Clerks began at the randomized starting station and proceeded to count and interview people as they drove the boat in the direction chosen. Users were recorded as shore anglers, boat anglers, commercial fishermen, hunters, recreational boaters, or miscellaneous users (campers, swimmers, etc.). The interview questions were typical of most creel surveys, including trip length, trip status (complete or incomplete), number of harvested fish, number of released fish, and their preference for species or species group. Users were also asked a question concerning the quality of the fishery.

One observer also made counts from a Cessna flown over the entire study area during a workday. Flights were scheduled for the same days as the creel clerks were working and one count was made per day. There were four shifts per day in April, August, September and October that were assigned equal probabilities and six possible shifts in May through July assigned unequal probabilities (Table 3). The flight shifts were shorter than the creel clerk shifts by about half. The starting point (river mile) for each flight was randomized along with the direction of travel (upstream or downstream). The plane was flown at a low speed and elevation so users could be counted and recorded as the groups previously described.

Recreational Effort

Effort was calculated for each day by methods outlined by Pollock et al. (1994). Data were analyzed separately for weekend and weekday stratum for each month. Effort for the work shift was estimated by:

$$\hat{e}_i = I_i \times T,$$

which is the progressive count of anglers *(I*) at time *i* multiplied by the period length (*T*). Total effort for the fishing period was estimated by dividing $\hat{e}_i$ by the combined probabilities for the shift and the section of river sampled that day. Mean daily effort was calculated and then expanded by multiplying by the number of days in a month for each stratum. Effort was also estimated for anglers seeking a particular species or species group based on their answer to a preference question during interviews. Effort by preference was calculated by multiplying the proportion of the anglers who reported fishing for a certain species or species group by total effort estimates. A conservative estimate of variance was calculated and expanded according to Pollock et al. (1994). Data from flights were similarly calculated, although a section probability was not included because the entire river was sampled in one day. Effort estimates of flight counts and clerk counts were compared using regression analysis.

Sport Angler Catch and Harvest

Catch and harvest were estimated from complete and incomplete trips of 0.5 h or more. Clerks recorded the number of harvested fish and the number of released fish; therefore, total catch was the sum of the two parameters and hereafter, total catch is referred to as "catch." Sport anglers included anglers that fished from boat, shore, or used trot- or limb-lines. Trip length was multiplied by the number of anglers in the party to get total angler-hours for each party interviewed. Catch rate for each party was calculated by dividing catch by effort (angler-hours). Interviews were dominated by incomplete trips (70%) so the mean of ratios method was used to calculate mean catch rates of fishing parties (Pollock et al. 1994). Daily effort was multiplied by the mean daily catch rate to get an estimate of catch for each day. Daily catch was averaged per stratum and expanded by the number of days in the strata for each month. Catches of different species or species groups were totaled by month and KOD and the proportions of each were multiplied by the expanded catch to get the estimated catch of each species or species group. Preference harvest rates were calculated for species or species groups that only include data from anglers who were specifically targeting that particular species or group. The Mann-Whitney *U*-test was used to test for differences in catch distributions between sport anglers and commercial fishermen for selected species.

Commercial Effort and Catch

Effort reported by commercial fishermen was analyzed separately because commercial fishermen were asked during the interview how much time they spent on the water rather than how long the nets were in the water. This would result in an inflated catch rate and

overestimation of catch. Consequently, the number of commercial fishing boats counted during the clerks shift was expanded by multiplying the count by two (two work shifts; AM and PM) and dividing by the section probability. The units would be commercial boats per day, or simply angler-days. It was not necessary to calculate total angler-hours from the creel survey because commercial fishermen were not asked to report how many people were pulling nets on a particular day. Instead, the commercial fishermen reported how many nets were used on a particular day, which gives nets per day. Angler-days from the creel count data were averaged per stratum and expanded by the number of days in a month. The expanded number was multiplied by the average number of nets used per commercial fishermen ($\bar{x}$ = 3.2) to get net-days to compare with data reported by commercial fishermen. For example, a commercial fisherman reported using four nets for 31 days in a month.

Reported effort 4 nets x 31 days = 124 net-days

Effort estimated for the month from creel counts was calculated in the following way to get the same units for comparison with reported effort:

Estimated effort 39 angler-days x 3.2 nets/angler = 124.8 net-days

Commercial fishermen reported catch in pounds (lbs). Thus, in order to compare with estimated catch from interviews, length frequencies were determined from commercial fishermen catches and proportions were multiplied by the estimated catch to get the number of fish per inch group. Standard, linear length-weight regressions were used to determine the lbs per inch group and data were summarized to get estimated commercial yield.

RESULTS

Recreational Effort

Anglers, hunters, recreational boaters, and miscellaneous users spent an estimated 326,271 h (SE = 14,811) on the East Fork White and White Rivers between Williams Dam and the mouth of the Wabash River from April to October 2003 (Table 4). Nearly 57% (185,184 h) of the total hours were in June, July, and August. Over 20% of the total effort was in August. Total effort for weekend days (163,413 h) was similar to weekdays (162,858); however, effort per day was higher on weekend days (2,724 h/d) compared to weekdays (1,058 h/d). Miscellaneous recreational users (e.g., campers, swimmers) spent more hours (93,756 h; SE = 8,301) on or near the river than any other group, although not statistically different from shore

anglers, boat anglers, and recreational boaters (Table 4). Shore angler effort was similar to boat angler effort for the entire study area. Recreational boaters spent an estimated 65,080 h on the river. Hunter effort was estimated at only 4,152 h. Recreational users and anglers were residents of 37 Indiana counties. Most of the users (51%) interviewed were from Martin and Lawrence counties and an additional 17% were from Dubois County. Only four users from another state were interviewed.

More effort was expended in Sector 2 (176,678 h) than in Sector 1 (149,593 h; Table 5). Shore anglers were the dominant user in Sector 1 with 41% (60,817 h) of the recreational hours for that portion of the river (Table 5; Figure 4). Miscellaneous users were the next highest in Sector 1 with 47,627 h followed by boat anglers at 29,541 h. Recreational boaters used the river an estimated 10,972 h in Sector 1. In contrast, recreational boaters were the dominant user group in Sector 2 with 54,108 h. Effort of boat anglers and miscellaneous users in Sector 2 was similar (Table 5; Figure 4). Hunter effort was greater in Sector 2 than in Sector 1, but hunter effort was the lowest of the activities in both sectors.

Sport angler pressure totaled 163,284 h (1,271 h/mi) for the entire study area. Effort ranged from 314 to 2,246 h/mi for different sections of the study area (Table 6). Average trip length calculated from complete trips was 3.1 h (n = 297; SE = 0.11); thus, anglers made an estimated 52,672 trips to the river from April to October 2003. Anglers preferred to fish for a greater diversity of species in Sector 1 (Table 7) than in Sector 2 (Table 8). Nearly 98% of the effort in Sector 2 was from anglers who preferred either catfish or “anything”. Anglers in Sector 1 preferred catfish (40%), followed by “anything” (21%), drum (12.3%), black bass (10.2%), and sauger or walleye (4.5%). Anglers who preferred catfish accounted for 50% of the total effort for the entire study area. Anglers fishing from boats averaged 2.1 persons/boat for the season compared to recreational boaters who averaged 2.5 persons/boat.

Recreational effort estimated from flight counts was 18,684 h (SE = 1,006), which was approximately 6% of the effort estimated from creel clerks counts (Table 9). Boat anglers and shore-anglers were the dominant users according to flight counts. There were significant relations ($P < 0.001$) between flight and creel daily effort estimates of boat anglers, but the regression line only explained 30% of the variation in effort (Figure 5). There were also significant relations ($P < 0.001$) between flight and creel daily effort estimates of shore anglers, but the regression line explained even less variation in effort ($r^2 = 0.17$; Figure 5). Recreational boaters were the next highest user group with 2,720 h (SE = 465), which was 4% of the estimated effort from creel clerk counts. Miscellaneous user effort (990 h) was only 1% of what was estimated by the creel clerks (93,756 h). Hunter effort (34 h) estimated from flight counts was less than 1% of the effort estimated form creel counts.

Sport Angler Catch and Harvest

Creel clerks conducted 998 interviews. Nearly 89% of the interviews were of shore and boat anglers, followed by trot- or limb-line fishermen (6%). The remaining 5% of the interviews were of commercial fishermen and recreational boaters. Total sport angler catch was estimated to be 176, 580 fish (1,374 fish/mi; Table 10). Catch rate for the study period was 1.1 fish/h. Anglers caught 1,604 fish/mi (771 - 2,607 fish/mi) in Sector 1 compared to 1,218 fish/mi (364 - 4,632 fish/mi) in Sector 2. Approximately 62% (109,141) of the fish caught were harvested (0.56 fish/h) for a total weight of 195,819 lbs. Over half (53%; n = 93,019) of the fish caught and 66% of the harvest were in Sector 2 (Figure 6). More fish were caught in August (40,786) than in any other month. The next highest catch was in May at 33,382 fish.

An estimated 80,617 channel catfish were caught and approximately 75% were harvested (60,088) at a mean TL of 15.9 in. Channel catfish harvest totaled 91,941 lbs (Table 10 and 11). Over 81% of the channel catfish harvest was in Sector 2. More channel catfish were harvested (17,738) in August than any other month. Anglers specifically targeting catfish harvested 0.55 channel catfish per hour for the entire season (Table 12). Mean monthly harvest rates of anglers who preferred channel catfish ranged from 0.21 to 0.94 fish/h. Sport anglers harvested significantly smaller channel catfish than commercial fishermen ($P < 0.0001$).

Freshwater drum was the next most caught species after channel catfish. Approximately 27,069 freshwater drum were harvested weighing 19,623 lbs and an additional 27,031 fish were released. The majority (71%) of freshwater drum were harvested in Sector 1. Freshwater drum were harvested at a mean TL of 11.4 in and ranged in size from 6 to 21 in. Anglers specifically targeting freshwater drum harvested 0.41 fish/h for the entire season and mean, monthly harvest rates ranged from 0 to 1.18 fish/h (Table 12). Over 35% of the freshwater drum were caught in May.

Blue catfish was the third most harvested species. Nearly 95% of the blue catfish caught (10,194) were harvested (9,645). The majority (71%) of the blue catfish were harvested in June, July, and August and 94% of the harvest was in Sector 2. Total weight harvested was approximately 51,525 lbs and harvested fish averaged 21.8 in. Anglers specifically targeting catfish harvested 0.06 blue catfish per hour for the season and monthly harvest rates ranged from 0.02 to 0.11 fish/h. Sport anglers harvested significantly smaller blue catfish than commercial fishermen ($P = 0.007$).

Anglers fishing for flathead catfish harvested 0.05 fish/h for the season and harvest rates ranged from 0.02 fish/h to 0.2 fish/h. Approximately 3,334 flathead catfish weighing 20,504 lbs were harvested. Over 88% of the flathead catfish caught were harvested and over 86% of the

harvest was in Sector 2. Harvested flathead catfish ranged from 11 to 34 in and averaged 23.4 in. Mean length of harvested flathead catfish fish did not differ between sport anglers and commercial fishermen (P = 0.307)

Approximately 1,842 crappie weighing 1,037 lbs were harvested at a mean TL of 10.2 in. Over 96% of the crappie were harvested in April, September, and October. Anglers specifically targeting crappie harvested 0.49 fish/h for the season and anglers targeting crappie or panfish harvested crappie at 0.63 fish/h for the season. Over 60% of the crappie were harvested in Sector 1.

Bluegill was the sixth most harvested species. Anglers targeting panfish or panfish and bass harvested 0.25 fish/h for the season and harvest rates ranged from 0.0 to 1.57 fish/h. Anglers harvested 1,681 bluegill weighing 330 lbs at mean TL of 6.2 in. Nearly 61% of the harvest was in June and August and all of the harvest occurred in Sector 1.

Spotted bass were caught and released (9,462) more than harvested (353). Anglers fishing for black bass or bass and panfish caught 0.46 fish/h and harvested 0.05 fish/h. Harvested fish averaged 12.6 in. Nearly all (98%) of the spotted bass were caught in Sector 1. The majority (94%) of the spotted bass caught were less than 12 in. Other black basses contributed little to overall harvest. Approximately 249 largemouth bass and 63 smallmouth bass were harvested. An additional 330 largemouth bass less than 12 in and 1,191 smallmouth bass less than 12 in were released. There were also 476 smallmouth bass greater than 12 in released.

An estimated 166 sauger and 222 walleye were harvested, all in August and October. An additional 408 walleye or sauger less than 14 in were released and no fish were released over 14 in. Anglers harvested walleye at a mean TL of 19.1 and fish ranged from 16 to 27 in. Harvested sauger averaged 16.4 in and ranged from 16 to 18 in. All the sauger and walleye were captured in Sector 1. Anglers targeting walleye or sauger harvested 0.08 fish/h for the season; however, there were only two months when caught fish were recorded and harvest rates were 0.19 and 0.38 fish/h in those months.

Anglers targeting striped bass or hybrid striped bass harvested 0.06 fish/h. Preference harvest rates ranged from 0.0 to 0.13 fish/h. More striped bass (1,090) than hybrid striped bass (519) were harvested. An additional 1,368 striped bass or hybrid striped bass were released. Over 66% (1,075) of the striped or hybrid striped bass were harvested in Sector 2. Harvested striped bass ranged from 15 to 20 in and averaged 17.5 in. Anglers harvested hybrid striped bass from 11 to 23 in and fish averaged 17.6 in.

Commercial Effort and Catch

Commercial effort was estimated at 2,712 net-days (SE = 153), which was 6% of what was calculated from reports submitted by commercial fishermen (45,196 net-days). Monthly reported and estimated commercial fishing efforts were positively correlated ($n = 7$; $r = 0.9285$; $P = 0.003$). However, the monthly reported commercial fishing effort was 17 times higher on average than monthly effort estimated from creel clerk counts. According to creel interviews, commercial fishermen caught 4.7 fish/net-day. Total estimated catch was 27,744 fish (SE = 1,402), of which 72% were harvested (19,941) for a total weight of 60,611 lbs. Commercial fishermen reported catching 96,327 lbs of fish, which was 1.6 times higher than what was estimated from creel interviews (Table13).

Estimated commercial harvest of blue catfish, channel catfish, flathead catfish, and freshwater drum followed similar trends to reported harvest by commercial fishermen (Table 13), the exception was shovelnose sturgeon. Estimated harvest of shovelnose sturgeon was 4,932 lbs compared to the 255 lbs reported by commercial fishermen. Commercial fishermen reported channel catfish as their most harvested species, which was similar to estimates from creel interviews. Channel catfish were harvested at a mean TL of 17.7 in and the distribution of catches differed significantly from sport angler catches ($Z = -5.6436$, $P < 0.0001$). Flathead catfish were the next most harvested species at a mean TL of 25.1 in and distributions of catches did not differ from sport angler catches ($Z = -0.8308$, $P = 0.461$). Blue catfish were harvested at a mean TL of 25.5 in and the distributions of catches were significantly longer than sport angler catches ($Z = -2.6966$, $P = 0.007$). Commercial fishermen also caught significantly larger freshwater drum than sport anglers ($Z = -2.0889$, $P = 0.0367$).

DISCUSSION

Effort estimated from flight counts and creel counts differed by more than an order of magnitude. It was assumed that creel clerk counts were more accurate because of the ability to detect within-day variation, because the creel clerk was in one section of the river for a longer period of time compared to the plane. Relations between flight and creel counts of boat or shore anglers may have been significant, but the two methods were not highly correlated ($r < 0.55$). If the two methods were better correlated, a model could be used to predict angler effort from flight counts on the sections of river that were not covered by the creel clerk. However, the regression line accounted for less than 31% of the variation when effort estimated by creel clerks was regressed against effort estimated from flight counts. It was also more cost efficient to use creel clerks than flights. It cost approximately $46,000 for the flight contract

($548/coverage-day) compared to approximately $18,350 ($146/coverage-day) to have two clerks cover the study area.

According to the 2001 U.S. Fish and Wildlife Survey, anglers that fished in Indiana spent an average $37/day on trip related and other expenses. Anglers made an estimated 52,672 trips to the study area from April to October 2003. Assuming that anglers only made one trip per day, total angler expenditures was $1,948,864 (52,672 trips x $37/trip) for the study period. This figure does not account for the full value of the sport angler fishery with other aspects such as relaxation, friendship, aesthetics, etc. Interestingly, the average trip expenditure for 2001 was lower than 1996 when anglers spent $50/day on trip and equipment related costs (USFWS 1996). Total recreational value could not be determined because there was not an average cost per day available for other recreational activities besides hunting and wildlife watching. However, any recreational costs would be in addition to angler expenditures.

Angler effort (1,271 h/mi) was comparable to estimated angler effort on the West Fork White River in 2002 (Ball, personal communication), but less than a similar stretch of the West Fork in 1989 (2,742 h/mi; Kiley and Keller 1990). Angler effort in this survey ranged from 314 to 2,246 h/mi (Table 6). A similar survey was conducted in 1993 on portions of the Ohio River bordering Ohio and Indiana and angler effort was estimated to be 2,655 h/mi (Schell et al. 1996). Anglers expended 1,708 h/mi during a creel survey of the Kankakee River in Northwest Indiana in 2002 (Roberston 2004). In the same survey, angler effort ranged from 671 h/mi to 4,726 h/mi for different sections of the river. Angler catch per effort was higher in this survey (1.1 fish/h) than in the Kankakee survey (0.35 fish/h). Total harvest of game fish was also greater in this survey (80,614 fish; 627 fish/mi) compared to the Kankakee survey where only 4,513 game fish were harvested (234 fish/mi).

Preference harvest rates were not readily available for large rivers in Indiana, but there was information for large reservoirs. Creel surveys were completed on Brookville Reservoir in 1990, 1991, and 2000 that covered similar time periods within the year (April through October) as this survey (Sapp and Ball 2001). Preference harvest rates of bluegill and crappie were higher in all three years at Brookville Reservoir compared to the current survey. In contrast, preference harvest rates of catfish, striped bass (and hybrids), and walleye or sauger were similar among all three surveys at Brookville and the current survey. Compared to a creel survey of Monroe Reservoir in 2000, preference harvest rates of bluegill, channel catfish, crappie, striped or hybrid bass, and walleye or sauger were higher in the current survey. In the Monroe creel survey, Schoenung (2001) stated that minimum criteria for a successful percid

fishery should have at least 5% of the effort devoted to the species and a minimum preference catch rate of 0.1 fish/h. In the current survey, 4.5% of the angler effort was spent fishing for walleye or sauger in Sector 1; no walleye or sauger were caught in Sector 2 and no anglers reported walleye or sauger as their preferred species in Sector 2. Preference catch rates of percids averaged 0.18 fish/h for the season and preference harvest rates averaged 0.08 fish/h. Although the preference harvest rate and effort directed towards percids were slightly lower than minimum criteria, much of the effort may have occurred before the creel survey began in April. It is also likely that effort and catch of flathead catfish were underestimated in this creel survey because many anglers target flathead catfish fish at night (Kirk Hansen, IDNR, personal communication). Flathead catfish ranked third in total catch of Ictalurids, below channel catfish and blue catfish. In contrast, flathead catfish were more abundant than blue catfish in IDNR surveys (T. Stefanavage, IDNR, personal communication), which corroborates the likelihood that flathead catfish catch and harvest were underestimated in this creel survey.

The upstream portion of the East Fork White River differed from the lower portion in many aspects. Shore anglers dominated the upstream section, mostly at Williams Dam, which was the upper boundary for the study area. Anglers spent more time fishing and preferred a wider diversity of fish species in the upstream portion of the river. Anglers also caught more fish per river mile in the upstream sector, which was not surprising because Williams Dam serves as a barrier to fish movement and tends to concentrate fish in the area. Almost twice the number of freshwater drum were harvested in Sector 1 compared to Sector 2. Walleye and sauger were only caught in the upstream portion of the river, despite being collected throughout the study area in a general survey conducted by IDNR personnel in September 2003 (Tom Stefanavage, personal communication). The majority of the black basses were caught in Sector 1. In contrast, recreational boating and anglers fishing from boats were more prominent in the lower portion of the river. Recreational boaters and boat anglers had 61% more effort in Sector 2 than Sector 1. Hunting was also more prevalent in Sector 2 than Sector 1. Channel catfish and flathead catfish were harvested more in the lower portion of the river. A surprisingly large number of freshwater drum were harvested in Sector 2 despite no anglers reporting drum as their preferred fish to catch. Anglers caught more *Morone* spp. in Sector 2 than in Sector 1. The majority of the estimated commercial effort and catch was in Sector 2, which was expected because the majority of the allowed commercial fishing area lies within the lower portion of the study area.

Commercial effort and catch that was calculated from reports submitted by commercial fishermen differed from what was estimated from creel clerk counts. Estimated effort was almost 50% lower than what was reported; however the difference in the estimated and reported

effort may be because of the reporting system. There was an option on the form for commercial fishermen to check if they "fished the river, but did not catch anything," so many times they checked the box but did not report their effort for the month. Also, it was unclear on many of the reports if the commercial fishermen actually had nets in the water on certain days, because they may have only wrote down information if they caught fish on that particular day. However, it was assumed that if they had, for example, wrote down two nets used on the 1st day of the month and no catch or effort was reported until the 14th day of the month when they caught fish, then 14 days of two nets each totaled 28 net-days. This was a common occurrence and could have led to an artificial increase in reported effort if they had not used their nets on some of the days in between lines where they reported catch. Tracking commercial fishermen effort and catch is just as important as tracking sport angler catch and this information is critical for tracking trends in commercial fishermen catch rates over time. Anglers harvested more than two times the biomass of fish compared to commercial fishermen. The IDNR tracks catch-rates of sport anglers, but we need to improve our methods of tracking commercial catch-rates and not just pounds of fish caught per year. Commercial fishermen in this study caught larger fish (3 of 4 species) than sport anglers. If commercial fishermen are efficiently capturing older fish and catch rates begin to steadily decline over time, management actions can be taken. However, this is contingent upon precise reporting from commercial fishermen.

RECOMMENDATIONS

There was no quantitative data previously available to biologists about the relative effort of the different sections used for the creel survey on the East Fork White and White Rivers. Information from biologists and other users familiar with the river was used to assign probabilities for each section. Data from this survey can be used to better allocate sampling effort among the sections if a similar creel survey were to be duplicated in the future. The observed proportions of the total effort and the proportions used in this survey did not differ much for Sector 1 (Table 14). Probabilities in Sector 2 could be changed to better reflect the proportions of total effort. However, optimal allocation could be used to sample the sections based on the proportion of the variance that each section contributed to the total variance of the sector (Table 14). Thus, if a section had a large variance, it should be sampled more often in the next survey, therefore, reducing overall variance and increasing precision. Unequal probabilities of combined section and shifts would be chosen with replacement in order to optimally allocate sampling. Also, time periods were sampled with equal probabilities in this study. Analysis of raw data counts reflects more usage by anglers in the evening shift. The proportions were approximately 40% for the AM shift and 60% for the PM shift. These

probabilities should be used next time the survey is implemented and for future large river creel surveys.

Estimates obtained from observers in an airplane flown over the study area were over a magnitude less than estimates from creel clerk counts. It was assumed that the creel clerk counts were more representative of effort, because of the ability to detect within-day variation unlike the flights where only one count could be made per day. Also, the flights cost almost four times more per coverage day than hiring two creel clerks to survey the river. Even if flights were an efficient method of estimating effort, creel clerks would still have to be hired to collect catch rate data during interviews. Therefore, flights are not recommended for future, large river creel surveys in Indiana.

The quality of data collected from reports submitted by commercial fishermen warrants improvement. A combination of better instructions and changes to the commercial reporting form would be a good start. A clearer set of instructions on how the commercial fishermen should report effort and catch needs to be included on the form. The only incentive for the commercial fishermen to properly report catch and effort is to keep their license, which should be enough incentive. However, commercial fishermen's reported catches and actual catches are not monitored. The idea that accurate information will only benefit them and the resource needs to be reinforced.

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Table 1. Sectors, sections, and stations used in May during the 2003 creel survey of the East Fork and White Rivers.

Section	Station	Begin River Mile	End River Mile	Probability
	Sector 1			
Section 1	Williams Dam	128.5	123.8	0.50
	Chase Ripple	123.8	116.0	
	Island Riffle	116.0	111.5	
	Indian Creek	111.5	105.1	
Section 2	Shoals RR Bridge	105.1	100.4	0.25
	Beech Creek	100.4	97.4	
	Boggs Creek	97.4	92.1	
Section 3	Hindostan Falls	92.1	87.2	0.25
	Barn Run	87.2	82.6	
	Crooked Creek	82.6	76.4	
	Sector 2			
Section 1	US 231 Bridge	76.4	71.4	0.17
	Portersville Bridge	71.4	67.0	
Section 2	Flat Rock Bridge	67.0	62.2	0.20
	Bear Creek	62.2	58.7	
	Unnamed Creek	58.7	54.0	
	Aikman Creek	54.0	49.4	
	East Fork White Mouth	49.4	45.1	
Section 3	Petersburg Bridge	45.1	37.7	0.23
	Sevenmile Bend	37.7	31.4	
	Wilson Creek	31.4	24.8	
	South Bend	24.8	18.5	
Section 4	Hazelton Bridge	18.5	12.0	0.40
	Brevoort Levee	12.0	3.6	
	Kelly’s Ripple	3.6	0.0	

Table 2. Sectors, sections, and stations used from June to October during the 2003 creel survey of the East Fork White and White Rivers.

Section	Station	Begin River Mile	End River Mile	Probability
	Sector 1			
Section 1	Williams Dam	128.5	123.8	0.50
	Chase Ripple	123.8	116.0	
	Island Riffle	116.0	111.5	
	Indian Creek	111.5	105.1	
Section 2	Shoals RR Bridge	105.1	100.4	0.25
	Beech Creek	100.4	97.4	
	Boggs Creek	97.4	92.1	
Section 3	Hindostan Falls	92.1	87.2	0.25
	Barn Run	87.2	82.6	
	Crooked Creek	82.6	76.4	
	Sector 2			
Section 1	US 231 Bridge	76.4	71.4	0.17
	Portersville Bridge	71.4	67.0	
Section 2	Flat Rock Bridge	67.0	62.2	0.10
	Bear Creek	62.2	58.7	
	Unnamed Creek	58.7	54.0	
Section 3	Aikman Creek	54.0	49.4	0.10
	East Fork White Mouth	49.4	45.1	
Section 4	Petersburg Bridge	45.1	37.7	0.115
	Sevenmile Bend	37.7	31.4	
Section 5	Wilson Creek	31.4	24.8	0.115
	South Bend	24.8	18.5	
Section 6	Hazelton Bridge	18.5	12.0	0.20
	Brevoort Levee	12.0	3.6	
Section 7	Kelly's Ripple	3.6	0.0	0.20

Table 3. Scheduled flight times and shift probabilities for the 2003 creel survey East Fork White and White Rivers.

Month	Time Period	Start Time	End Time	Probability
April, August,	1	7:00 AM	10:00 AM	0.25
September, and	2	10:00 AM	1:00 PM	0.25
October	3	1:00 PM	4:00 PM	0.25
	4	4:00 PM	7:00 PM	0.25
May, June, and	1	5:30 AM	8:00 AM	0.148
July	2	8:00 AM	10:30 AM	0.185
	3	10:30 AM	1:00 PM	0.148
	4	1:00 PM	3:30 PM	0.148
	5	3:30 PM	6:00 PM	0.185
	6	6:00 PM	8:30 PM	0.185

Table 4. Estimated total effort (h) from a roving creel survey of different user groups on 128.5 mi of the East Fork White and White Rivers, April to October 2003. Standard errors are in parentheses.

	Month							
User	April	May	June	July	August	Sept.	October	Total
Boat anglers	6,468	8,699	15,301	14,159	20,911	7,120	6,802	79,459
SE	(1,556)	(2,796)	(3,774)	(4,238)	(3,286)	(1,474)	(1,041)	(7,516)
Hunters	486	0	0	0	105	2,690	871	4,152
SE	(357)	-	-	-	(105)	(2,403)	(354)	(2,457)
Miscellaneous	11,099	19,511	14,303	13,887	14,612	10,000	10,345	93,756
SE	(2,552)	(3,913)	(3,726)	(4,351)	(2,960)	(1,621)	(1,697)	(8,301)
Recreational boaters	5,556	5,163	10,518	14,186	17,673	7,595	4,388	65,080
SE	(2,204)	(1,514)	(2,386)	(4,230)	(3,348)	(2,362)	(1,194)	(6,996)
Shore anglers	8,483	11,347	18,892	16,583	14,056	7,455	7,010	83,825
SE	(1,374)	(1,990)	(3,542)	(3,872)	(1,804)	(1,098)	(1,067)	(6,244)
							Total	326,271
							SE	(14,811)

Table 5. Estimated total effort (h) and standard errors of different user groups from creel clerk counts, grouped by sector, for the East Fork White and White Rivers, 2003.

	Sector 1		Sector 2	
User	Effort (h)	SE	Effort (h)	SE
Boat anglers	29,541	2,939	49,918	6,918
Hunters	636	278	3,515	2,441
Miscellaneous	47,627	3,655	46,129	7,453
Recreational boaters	10,972	1,625	54,108	6,805
Shore anglers	60,817	5,150	23,008	3,530

Table 6. Proportion of estimated effort and catch of sport anglers on the East Fork White and White Rivers, 2003.

Section	Proportion of effort	Estimated effort (h)	Estimated Effort (h/mi)	Proportion of catch	Estimated catch (n)	Estimated catch (n/mi)
			Sector 1			
1	0.53	47,890	2,047	0.73	61,000	2,607
2	0.19	17,168	1,321	0.12	10,027	771
3	0.28	25,300	1,611	0.15	12,534	798
			Sector 2			
1	0.08	6,024	641	0.14	10,855	1,155
2	0.17	12,395	953	0.12	12,914	993
3	0.27	19,400	2,180	0.26	24,144	2,713
4	0.19	14,130	1,031	0.16	14,786	1,079
5	0.11	8,215	637	0.10	9,545	740
6	0.06	4,678	314	0.06	5,428	364
7	0.11	8,084	2,246	0.16	15,347	4,632

Table 7. Estimated effort (h) from a roving creel survey of different preference groups of anglers for Sector 1 of the East Fork White and White Rivers, April to October 2003.

	Month							
Preference	April	May	June	July	August	Sept.	Oct.	Total
Anything	2,203	1,209	4,523	3,949	3,748	2,335	1,401	19,368
Bass / panfish	264	134	0	0	0	0	0	399
Black bass	529	134	624	376	4,889	1,061	1,616	9,229
Bluegill	264	403	624	0	2,18	318	0	3,728
Carp / buffalo	0	0	0	0	652	0	108	760
Catfish / bullheads	1,410	7,925	7,642	6,206	7,170	4,458	1,616	36,427
Crappies	1,146	0	312	188	163	0	754	2,563
Smallmouth bass	0	0	468	0	0	0	0	468
Drum	617	3,358	1,560	1,316	1,630	1,486	1,185	11,152
Panfish	264	0	312	0	0	0	0	576
Rock bass	0	0	0	0	0	0	0	0
Striped / hybrid bass	88	0	156	188	978	106	108	1,624
Suckers	0	0	0	0	0	0	0	0
Walleye / sauger	617	269	780	188	815	318	1,077	4,064
							Total	90,358

Table 8. Estimated effort (h) from a roving creel survey of different preference groups of anglers for Sector 2 of the East Fork White and White Rivers, April to October 2003.

Preference	Month							
	April	May	June	July	August	Sept.	Oct.	Total
Anything	3,483	472	12,281	4,999	2,716	561	1,810	26,323
Bass / panfish	0	0	0	0	0	0	0	0
Black bass	0	0	0	0	0	281	0	281
Bluegill	0	0	0	0	0	0	0	0
Carp / buffalo	0	0	0	0	0	0	0	0
Catfish / bullheads	4,064	6,141	4,912	13,331	10,088	3,369	3,102	45,007
Crappies	0	0	0	0	0	281	517	798
Drum	0	0	0	0	0	0	0	0
Panfish	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	0	0	0
Smallmouth bass	0	0	0	0	0	0	259	259
Striped / hybrid bass	0	0	0	0	0	0	259	259
Suckers	0	0	0	0	0	0	0	0
Walleye / sauger	0	0	0	0	0	0	0	0
							Total	72,926

Table 9. Estimated total effort (h) and standard errors of different user groups from flight counts, grouped by sector, for the East Fork White and White Rivers, 2003.

	Sector 1		Sector 2	
User	Effort (h)	SE	Effort (h)	SE
Boat Anglers	4,307	370	3,569	296
Hunters	34	34	0	-
Miscellaneous	561	150	429	102
Recreational	1,217	315	1,502	342
Shore Anglers	6,474	719	591	141

Table 10. Estimated number of fish species released or harvested by sport anglers in each sector during the creel survey of the East Fork White and White Rivers, 2003. Data not collected for a species or group are represented by "-".

Common name	Sector 1		Sector 2		Total
	Harvested	Released	Harvested	Released	
Blue catfish	544	52	9,101	497	10,194
Bluegill	1,681	0	0	0	1,681
Buffalo	422	0	0	0	422
Carp	0	0	125	0	125
Channel catfish	11,190	12,022	48,898	8,506	80,616
Crappie	1,110	-	732	-	1,842
Flathead catfish	441	17	2,893	414	3,765
Freshwater drum	19,287	16,688	7,782	10,343	54,100
Hybrid striped bass	365	-	154	-	519
Largemouth bass	0	205	249	125	579
Miscellaneous	225	4,837	0	828	5,890
Misc. sunfish	686	-	0	-	686
Rock bass	20	0	0	0	20
Sauger	166	-	0	-	166
Smallmouth bass	63	1,667	0	0	1,730
Shovelnose sturgeon	25	0	0	0	25
Spotted bass	353	9,308	0	154	9,815
Striped bass	39	-	1,051	-	1,090
Striped or hybrid bass	-	1,368	-	0	1,368
Suckers	0	0	0	0	0
Walleye	222	-	0	-	222
Walleye or sauger	-	408	-	0	408
White catfish	150	-	401	-	551
White bass	0	-	766	-	766

Table 11. Estimated number and weight of fish harvested by sport anglers, East Fork White and White Rivers. The length frequency distribution of the fish measured by the creel clerk (n) was expanded by the total estimated harvest by species per inch group. The intercept and slope was used to calculate weight per inch group.

Species or group	n	Mean TL (in)	Intercept	Slope	Estimated Harvest	Estimated Weight (lbs)
Blue catfish	77	21.8	-5.921[1]	3.342	9,645	51,525
Bluegill	69	6.2	-3.128	3.013	1,681	330
Buffalo[2]	7	21	-3.419	3.113	422	2,224
Carp	4	19.5	-3.066	2.809	125	458
Channel catfish	724	15.9	-3.302	2.860	60,088	91,941
Crappie[3]	49	10.2	-3.381	3.084	1,842	1,037
Flathead catfish	32	23.4	-3.100	2.799	3,334	20,504
Freshwater drum	703	11.4	-3.575	3.204	27,069	19,623
Hybrid striped bass	13	17.6	-3.448	3.139	519	1,839
Largemouth bass	3	12.0	-3.490	3.191	249	270
Misc. sunfish[4]	23	4.9	-3.104	2.996	686	67
Rock bass	1	8.0	-3.209	3.083	20	8
Sauger	7	16.4	-3.671	3.187	166	267
Smallmouth bass	4	14.8	-3.491	3.200	63	113
Shovelnose sturgeon	1	28.0	-2.911	2.417	25	97
Spotted bass	24	12.6	-3.533	3.215	353	364
Striped bass	6	17.5	-3.358	3.007	1,090	2,680
Walleye	8	19.1	-3.642	3.180	222	698
White catfish	7	17.1	-3.657	3.203	551	1,113
White bass	23	11.8	-3.394	3.081	766	661
					Total	195,819

[1] Intercept value is in metric (mm)
[2] Length-weight regression was for smallmouth buffalo
[3] Length-weight regression was for white crappie
[4] Length-weight regression was for longear sunfish

Table 12. Preference harvest rates (fish/h) of anglers by month and for the season, East Fork White and White Rivers, 2003.

	Month							
Species or group	April	May	June	July	August	Sept.	Oct.	Season
Blue catfish	0.11	0.05	0.09	0.04	0.07	0.02	0.04	0.06
Bluegill	0.20	0.00	1.57	0.00	0.00	0.00	0.00	0.25
Channel catfish	0.57	0.38	0.44	0.42	0.92	0.21	0.94	0.55
Crappie	0.21	-	0.00	0.00	0.00	2.67	0.90	0.63
Flathead catfish	0.20	0.02	0.04	0.03	0.04	0.02	0.02	0.05
Freshwater drum	1.14	1.18	0.15	0.00	0.15	0.10	0.12	0.41
Spotted bass	0.06	0.24	0.00	0.00	0.00	0.03	0.01	0.05
Striped or hybrid bass	0.13	-	0.00	0.12	0.00	0.00	0.08	0.06
Walleye and Sauger	0.00	0.00	0.00	0.00	0.19	0.00	0.38	0.08

Table 13. Estimated number and weight of fish harvested by commercial fishermen, East Fork White and White Rivers, 2003. The length frequency distribution of the fish measured by the creel clerk (n) was expanded by the total estimated harvest by species per inch group.

Species	n	Mean TL	Estimated catch	Estimated harvest (N)	Estimated total weight (lbs)	Reported total weight (lbs)
Blue catfish	18	25.5	819	819	6,216	11,700
Channel catfish	183	17.7	13,537	12,496	25,517	42,523
Flathead catfish	45	25.1	3,326	3,106	22,699	37,395
Freshwater drum	14	12.5	2,839	1,314	1,247	4,454
Shovelnose sturgeon	31	24.0	1,853	1,853	4,932	255
				Total	60,611	96,327

Table 14. The probability used for each section during the creel survey along with the observed proportion of total effort and variance for each section of the East Fork White and White Rivers, 2003.

Section	Probability used	Proportion of estimated total effort	Proportion of total variance
		Sector 1	
1	0.50	0.53	0.33
2	0.25	0.19	0.30
3	0.25	0.28	0.37
		Sector 2	
1	0.17	0.08	0.03
2	0.10	0.17	0.11
3	0.10	0.27	0.27
4	0.115	0.19	0.27
5	0.115	0.11	0.12
6	0.20	0.06	0.13
7	0.20	0.11	0.06

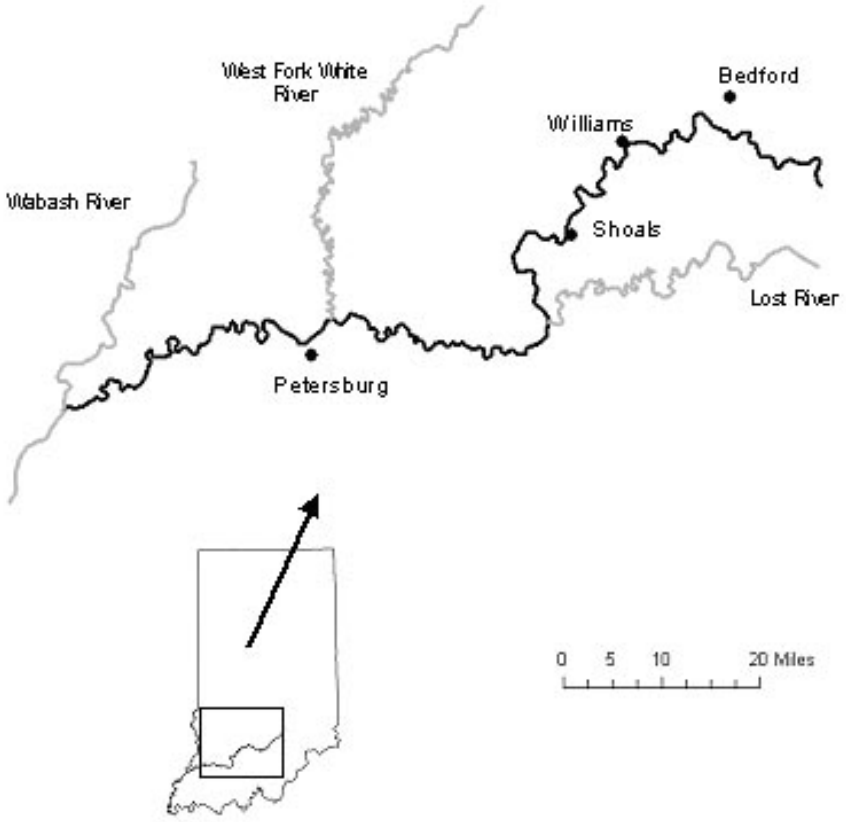

Figure 1. Study area from Williams Dam to the confluence with the Wabash River, 2003.

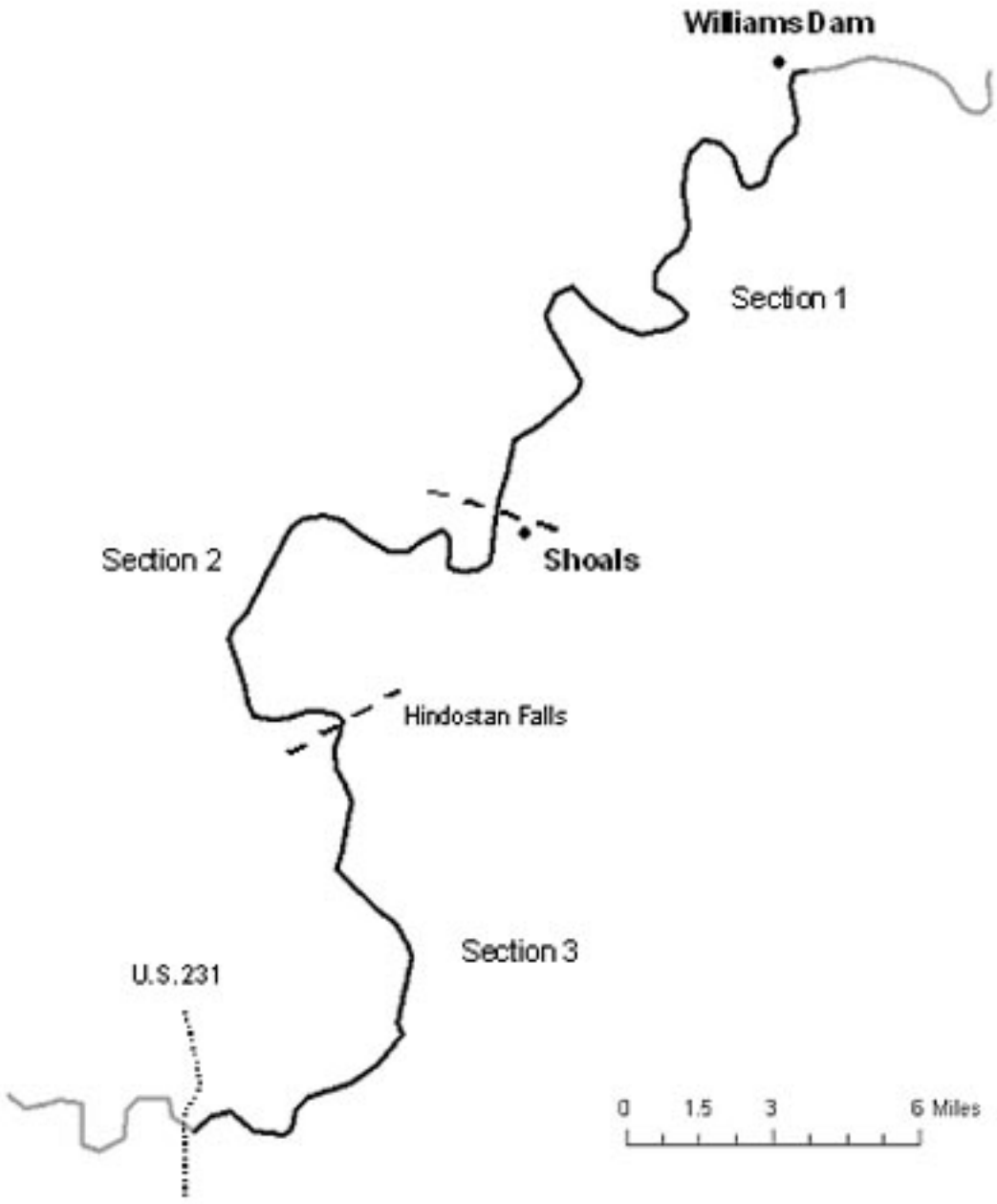

Figure 2. Sector 1 of the study area from Williams Dam to U.S. 231 Bridge. The dashed lines are the endpoints of the sections, East Fork and White Rivers, 2003.

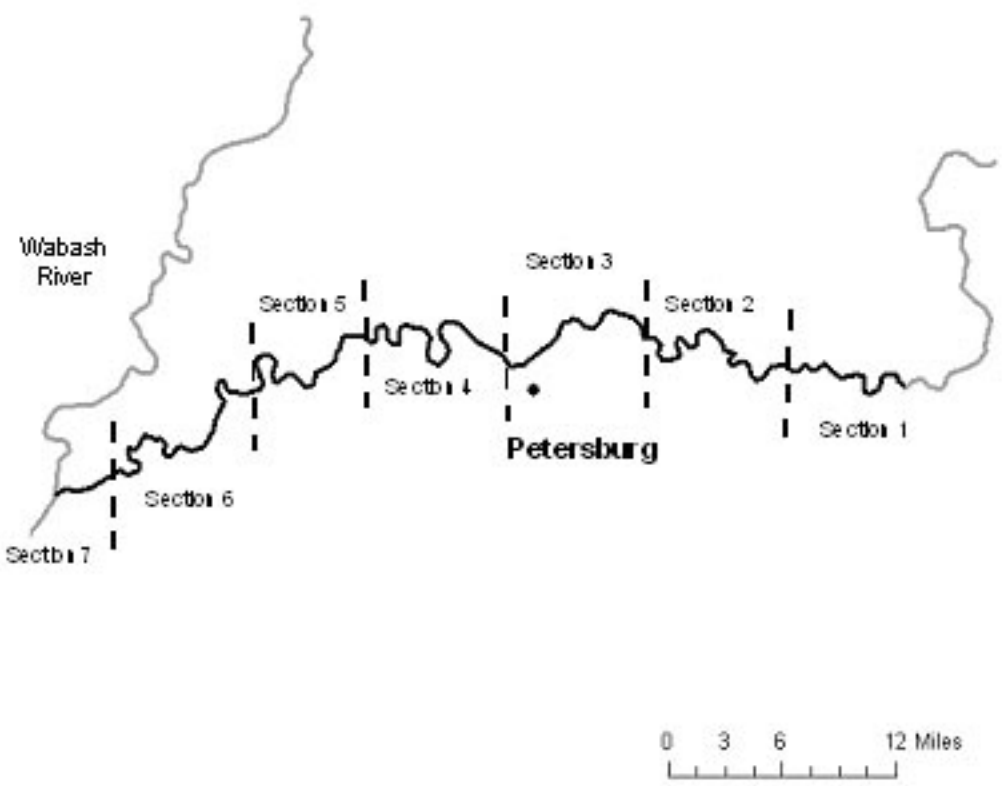

Figure 3. Sector 2 of the study area from U.S. 231 Bridge to the confluence with the Wabash River. The dashed lines are the endpoints of the sections, East Fork and White Rivers, 2003.

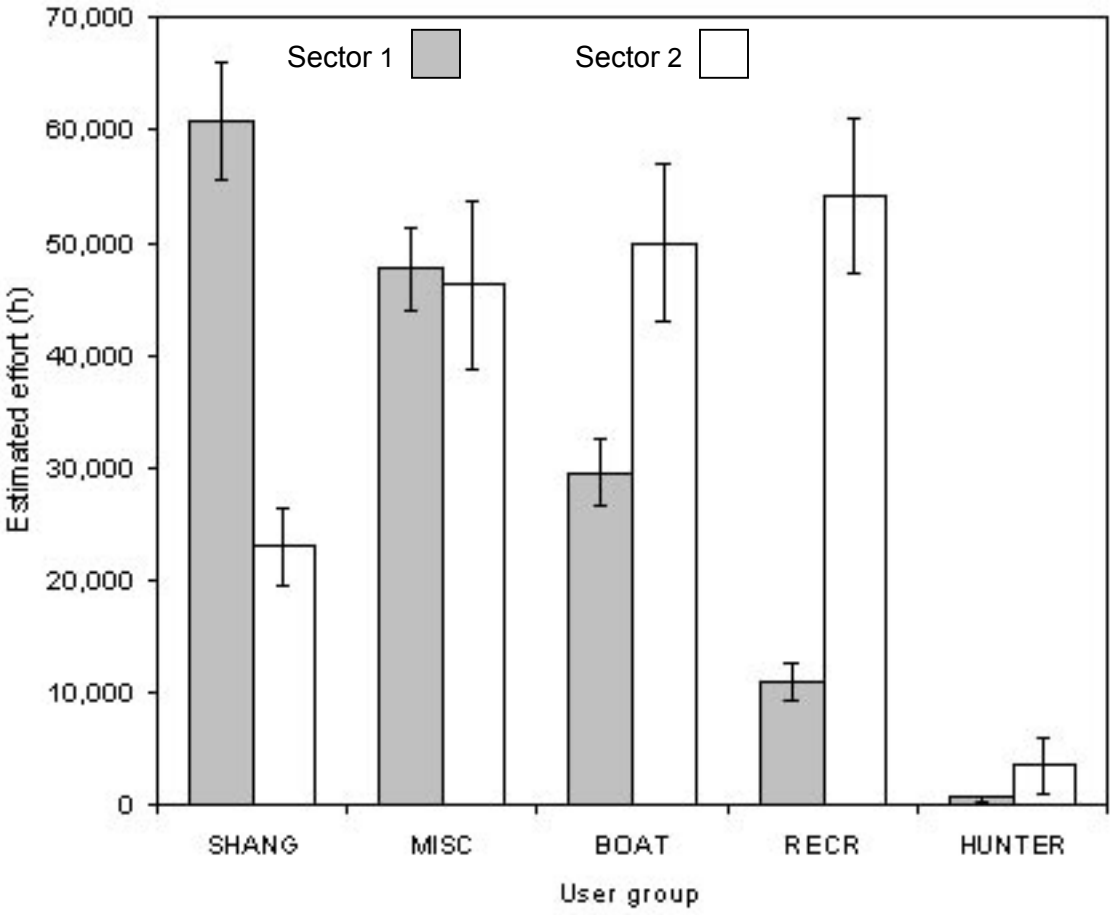

Figure 4. Estimated total effort by user group and sector for the East Fork White and White Rivers, 2003. Abbreviations are: shore anglers (SHANG), miscellaneous (MISC), boat anglers (BOAT), recreational (RECR), and hunters (HUNTER). Standard error bars are included.

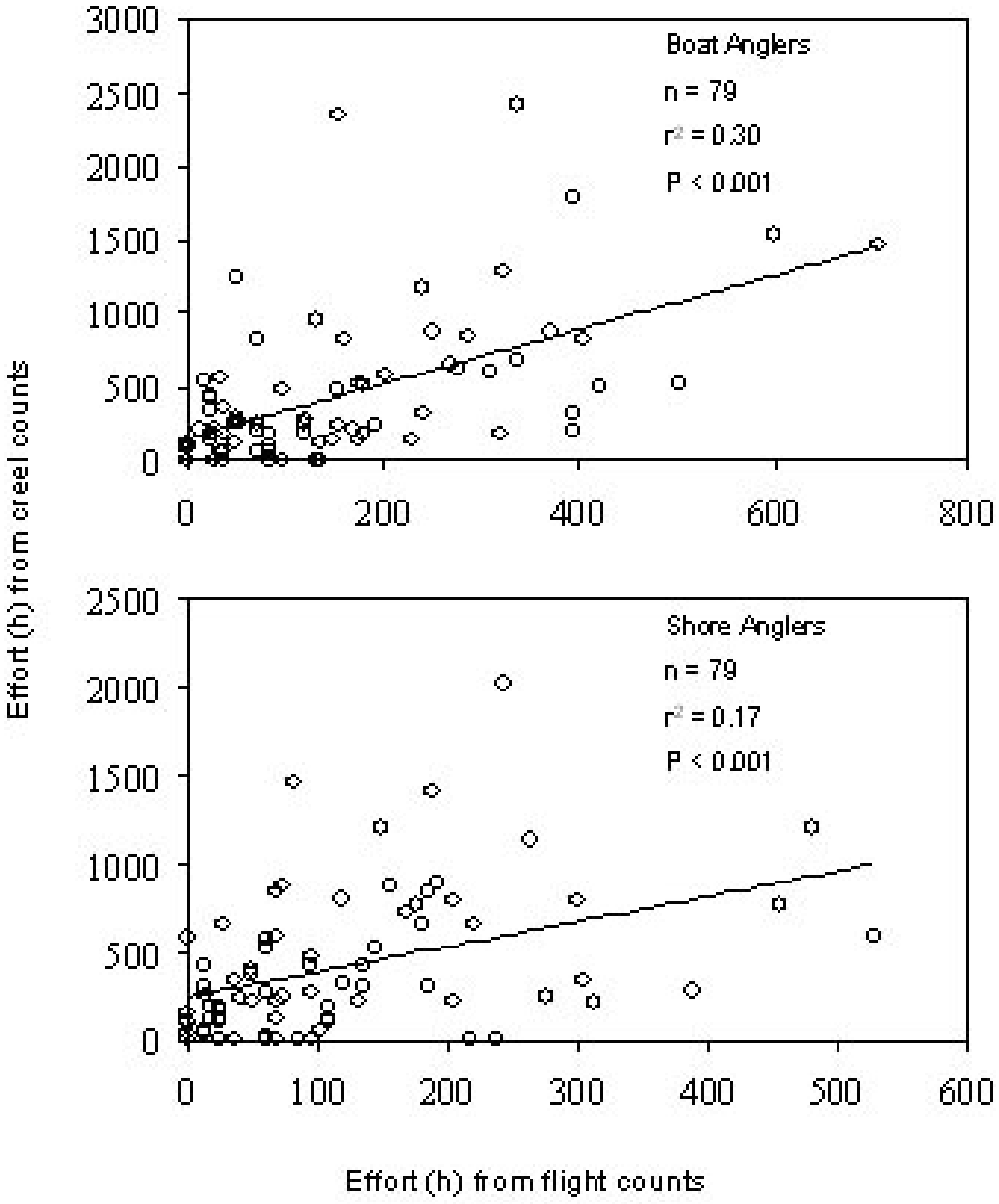

Figure 5. Comparison of effort estimated by flight and creel counts for shore anglers and boat anglers, East Fork White and White Rivers, 2003.

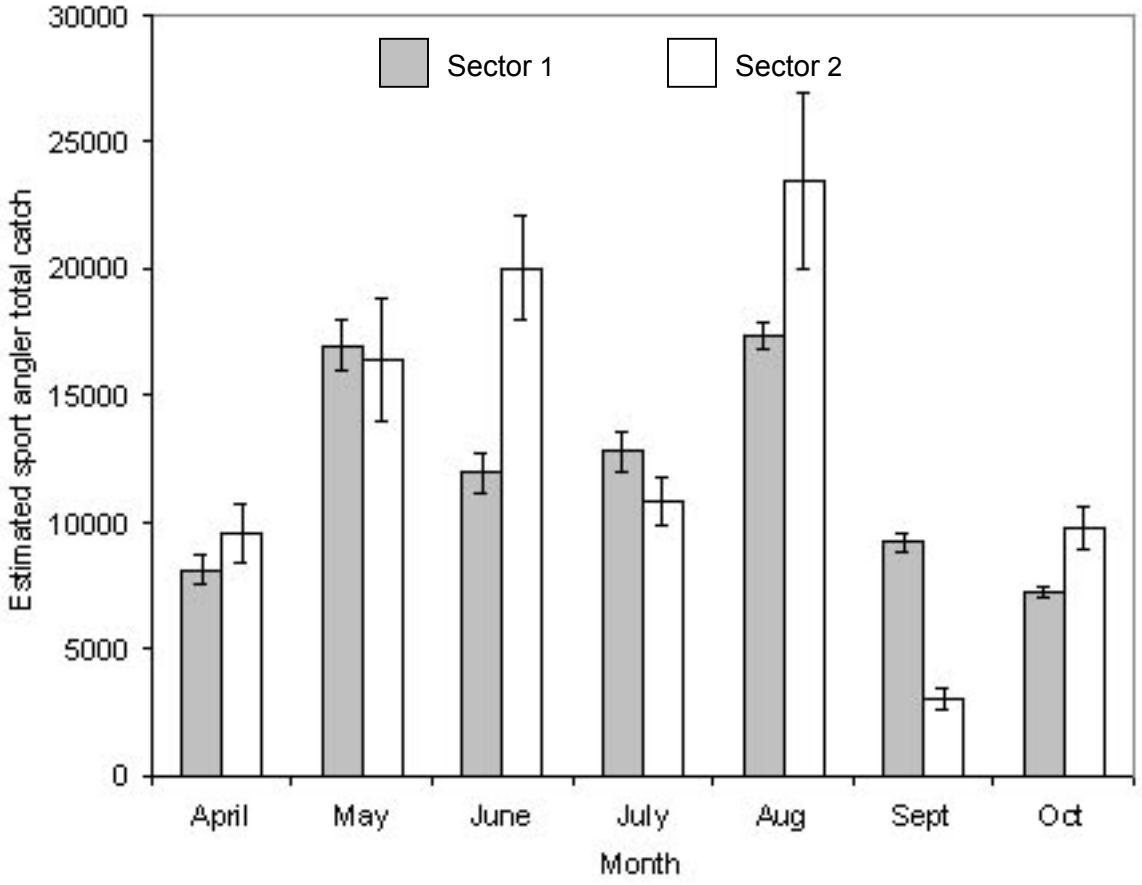

Figure 6. Estimated sport angler catch by sector for the East Fork White and White Rivers, 2003. Standard error bars are included.